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Douglas et al.

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(54) **LED HIGH BAY LIGHTING SOURCE**

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Related U.S. Application Data

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F21V 7/04	(2006.01)
F21V 29/77	(2015.01)
F21V 29/02	(2006.01)
F21V 3/00	(2015.01)
F21S 8/02	(2006.01)
F21Y 101/02	(2006.01)
F21V 29/505	(2015.01)
F21V 29/507	(2015.01)

(52) **U.S. Cl.**

CPC . ***F21K 9/13*** (2013.01); ***F21V 7/043*** (2013.01); ***F21V 7/05*** (2013.01); ***F21V 29/77*** (2015.01); *F21K 9/00* (2013.01); *F21S 8/02* (2013.01); *F21V 3/00* (2013.01); *F21V 29/02* (2013.01); *F21V 29/505* (2015.01); *F21V 29/507* (2015.01); *F21Y 2101/02* (2013.01)

(58) **Field of Classification Search**

CPC F21V 29/2225; F21K 9/13
USPC 362/235, 249.02, 294, 373
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,905,634	B2 *	3/2011	Agurok et al.	362/296.01
8,342,710	B2 *	1/2013	Rahbar-Dehghan	362/249.02
8,393,757	B2 *	3/2013	Uemoto et al.	362/249.03
8,434,899	B2 *	5/2013	Lee et al.	362/249.02
8,764,247	B2 *	7/2014	Pattekar et al.	362/294
2009/0027889	A1 *	1/2009	Kang et al.	362/294
2009/0046464	A1 *	2/2009	Liu et al.	362/294
2011/0222307	A1 *	9/2011	Kong	362/554
2011/0267812	A1 *	11/2011	Van De Ven et al.	362/235
2012/0092870	A1 *	4/2012	Tralli et al.	362/249.02
2014/0126213	A1 *	5/2014	Pattekar et al.	362/294

* cited by examiner

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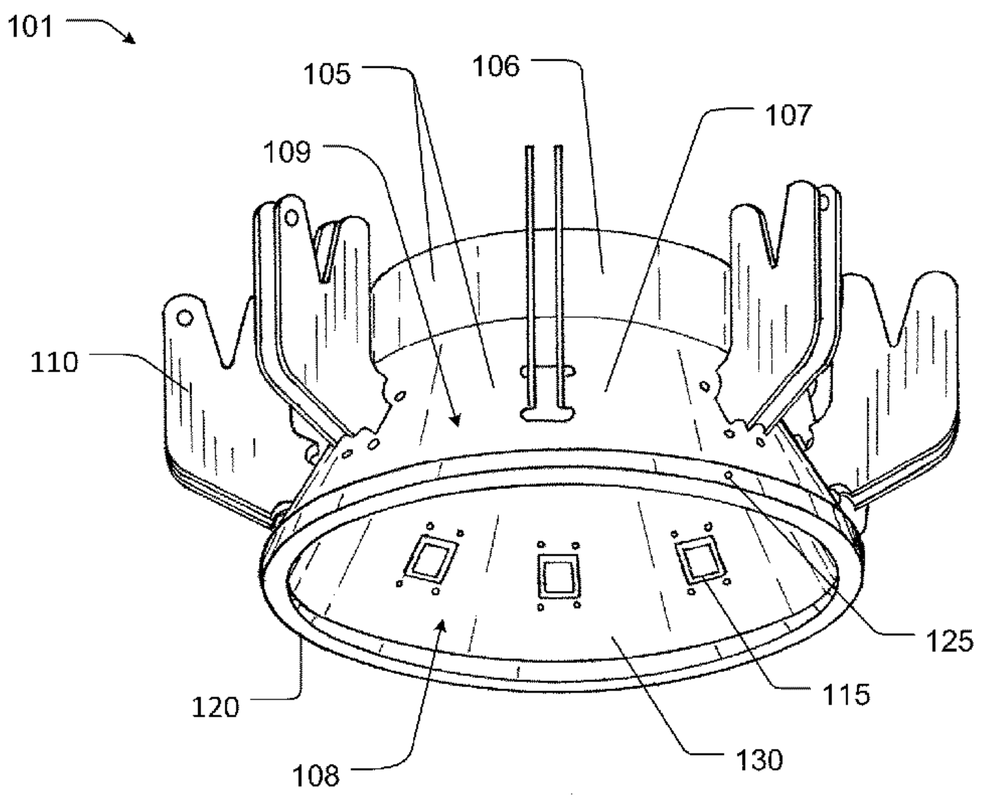
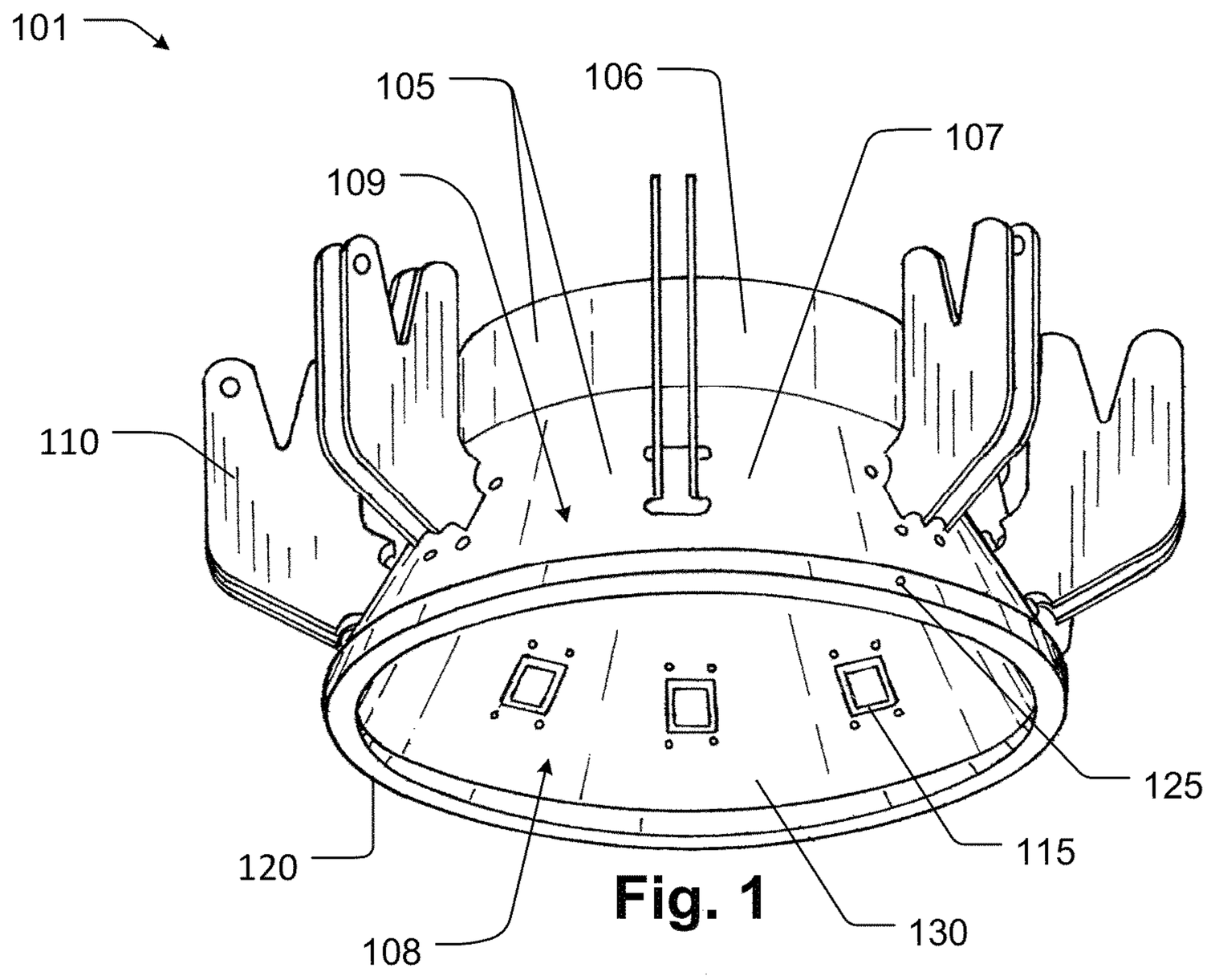
(74) *Attorney, Agent, or Firm* — Theodore C. Huff

(57) **ABSTRACT**

A lighting device includes a housing having an inner surface and outer surface and a plurality of LEDs mounted at the inner surface, the LEDs mounted in a radially symmetrical configuration. The inner surface may be made of or coated with reflective material. The lighting system may further include, individually or in any combination, following: heat sink fins mounted on the outer surface; a reflective plate for reflecting light in a desired direction; a reflective tube for redirecting light from the LEDs. The housing may include a cylindrical section and a conic section.

3 Claims, 10 Drawing Sheets




101
105
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125
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115
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130

Fig. 1

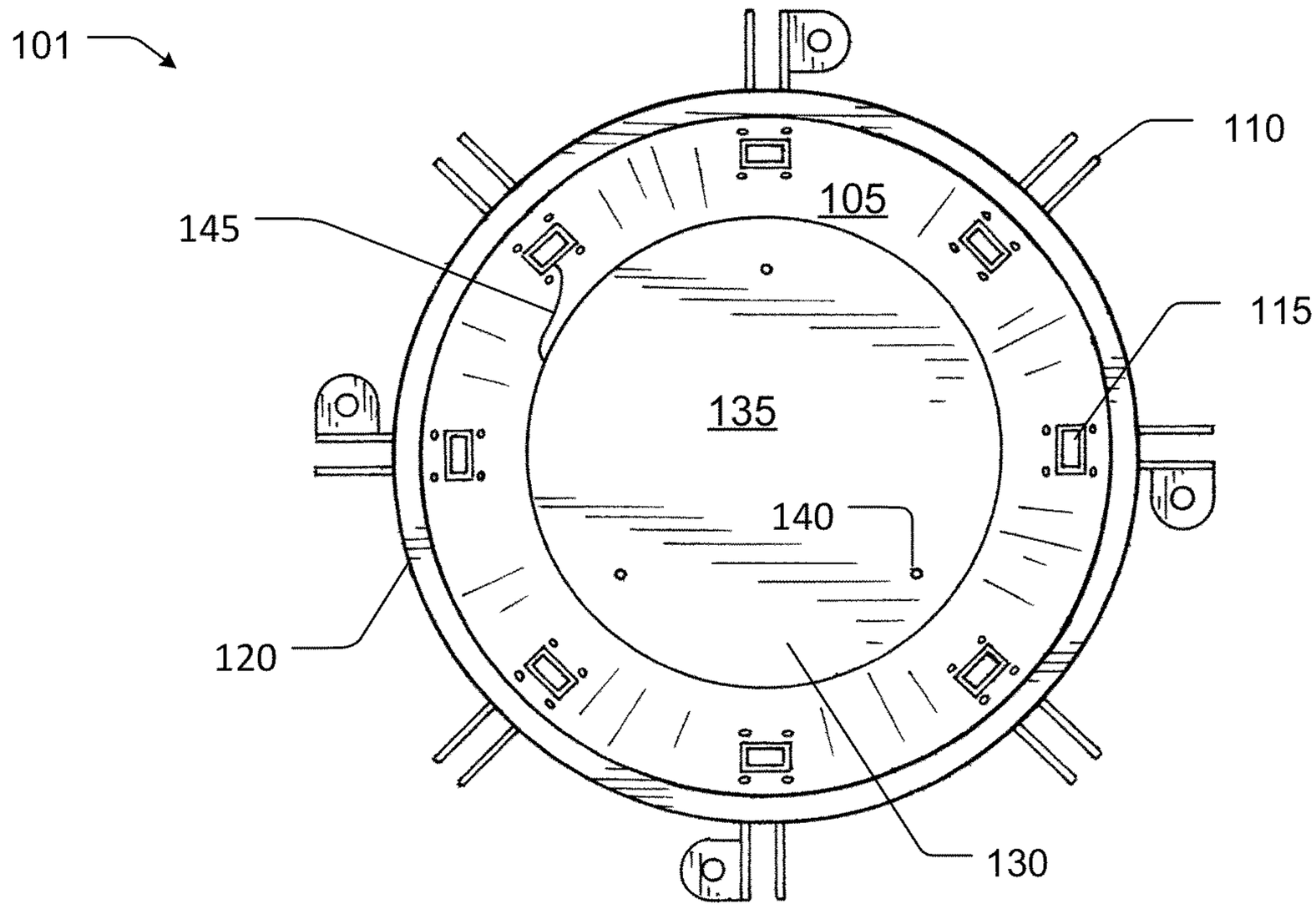
101
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Fig. 2

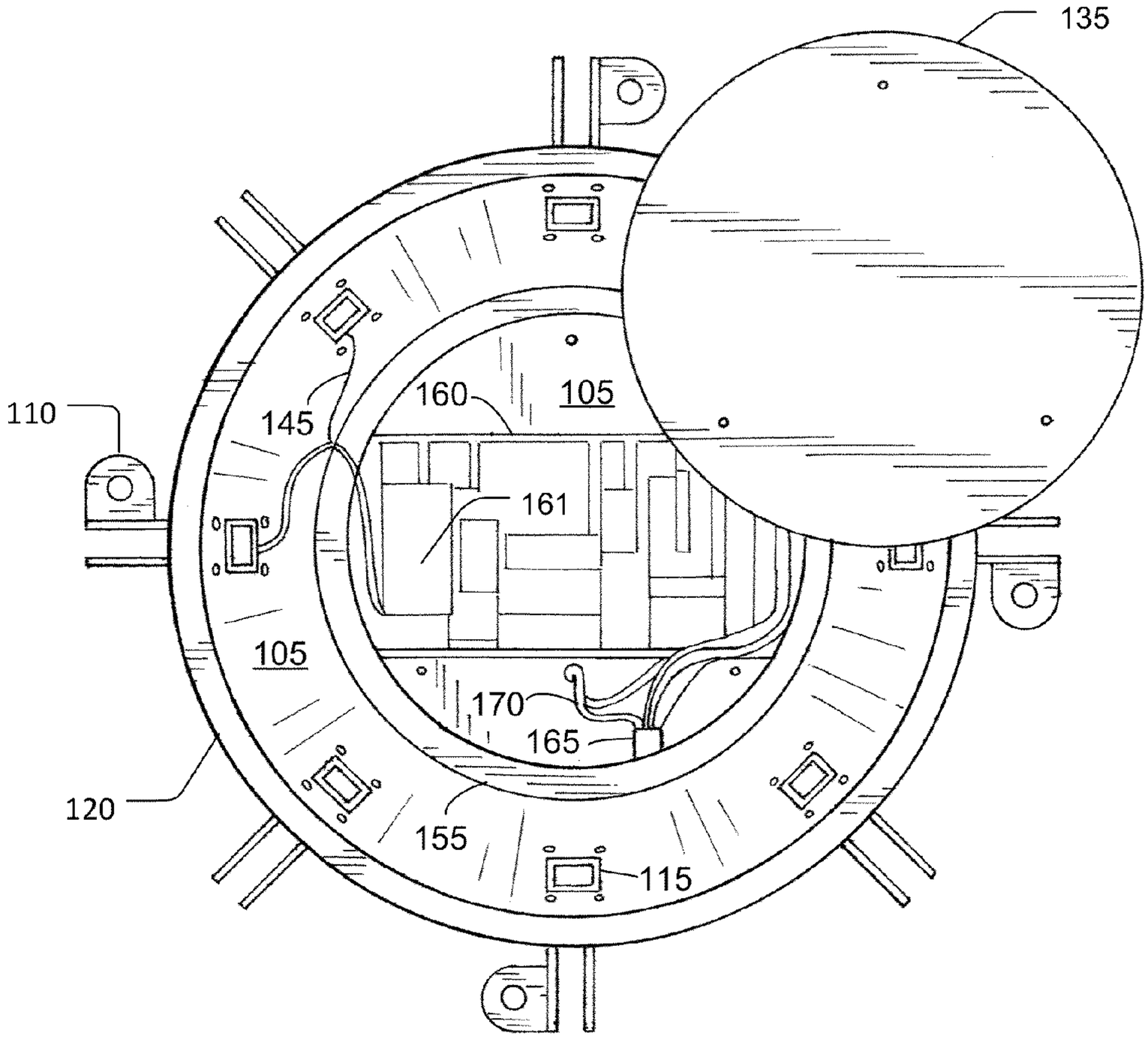

Fig. 3

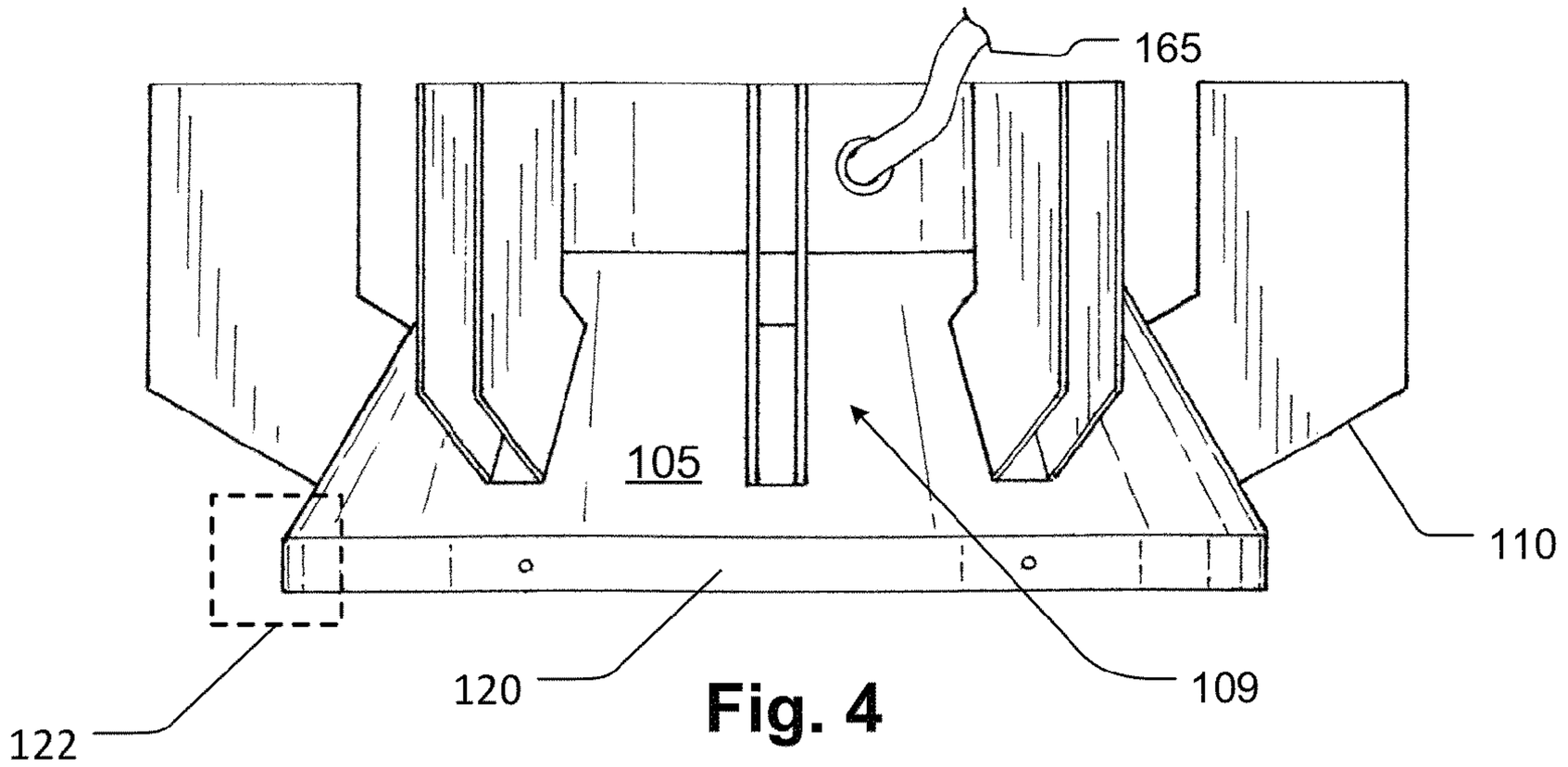

Fig. 4

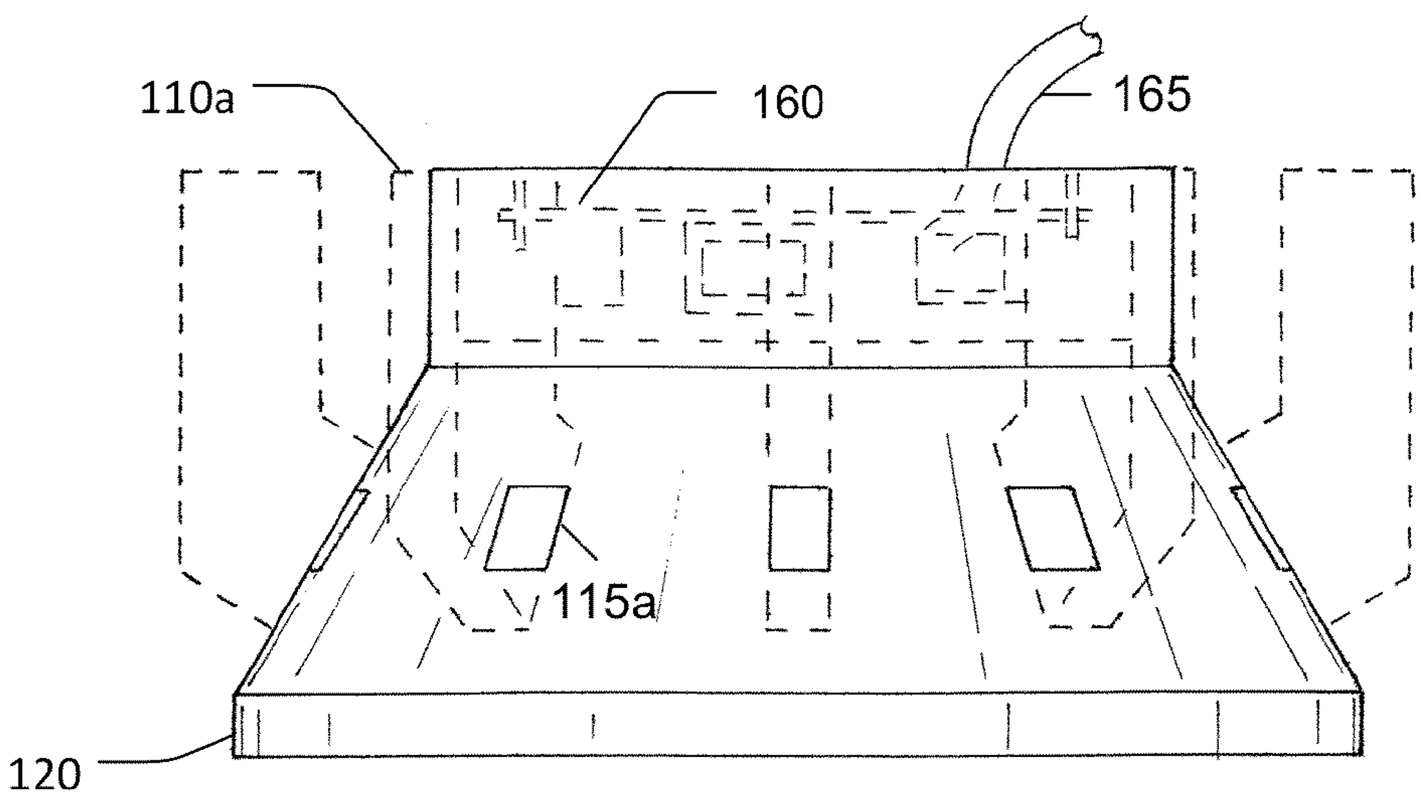

Fig. 5

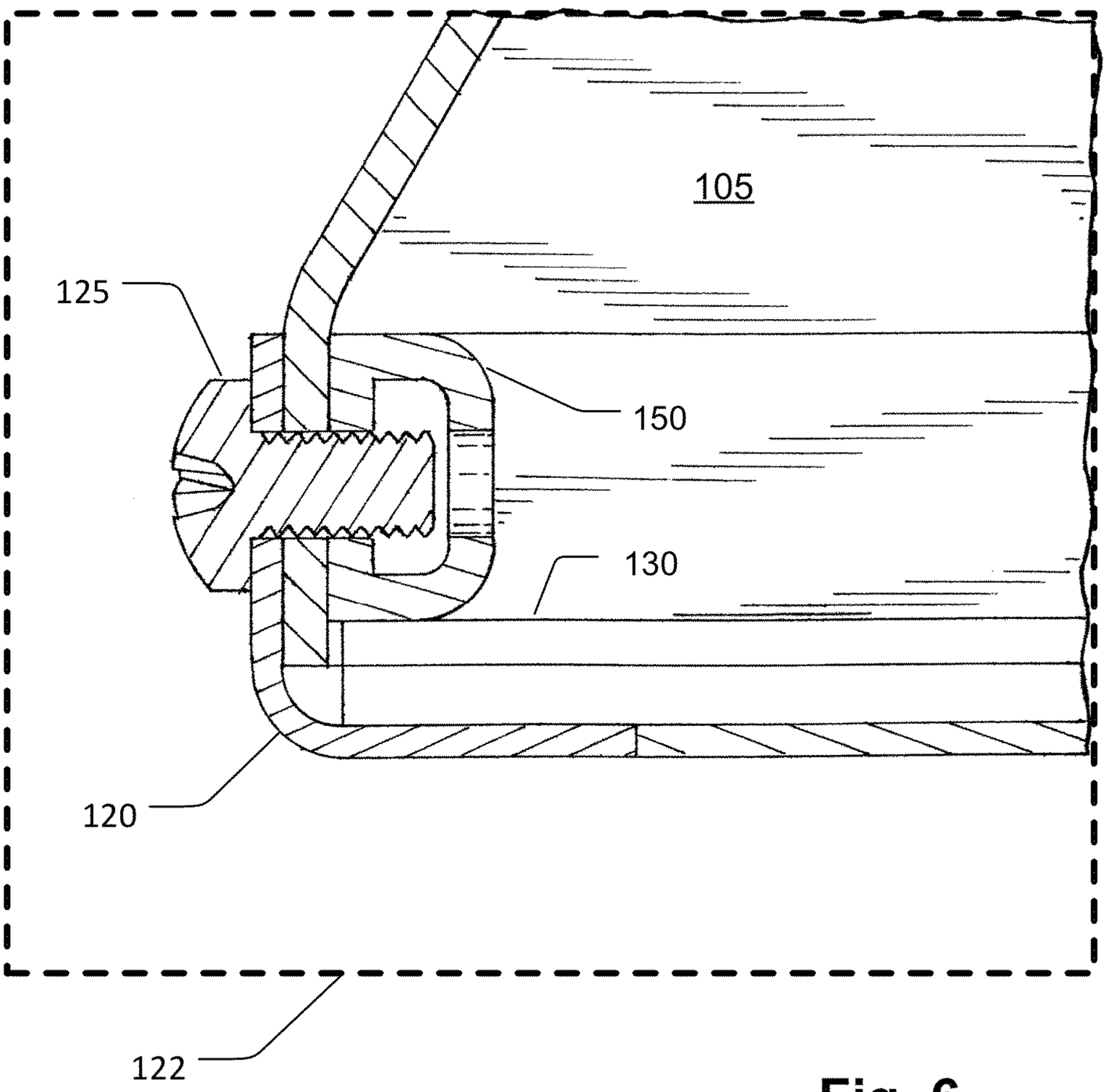

Fig. 6

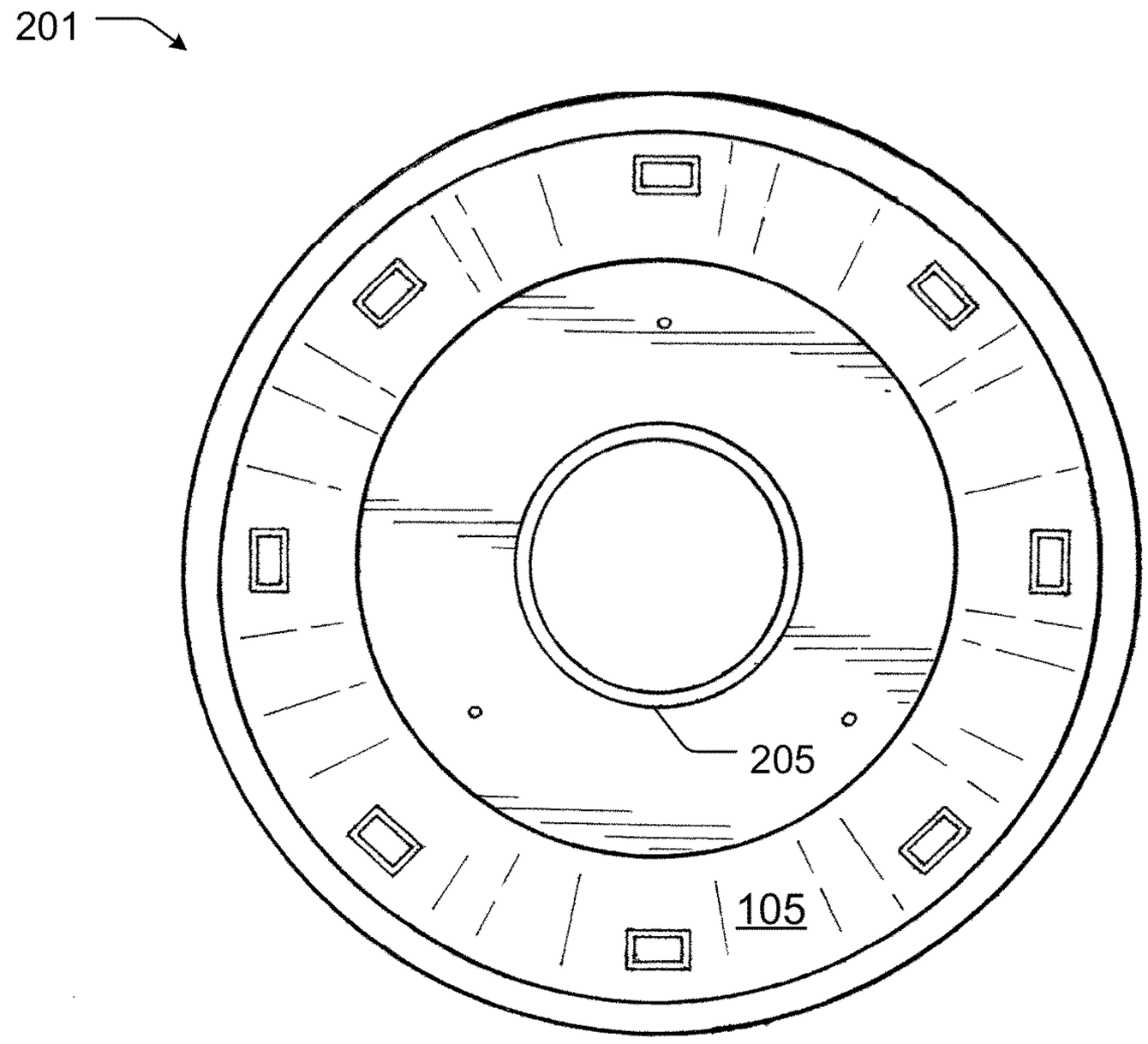

Fig. 7

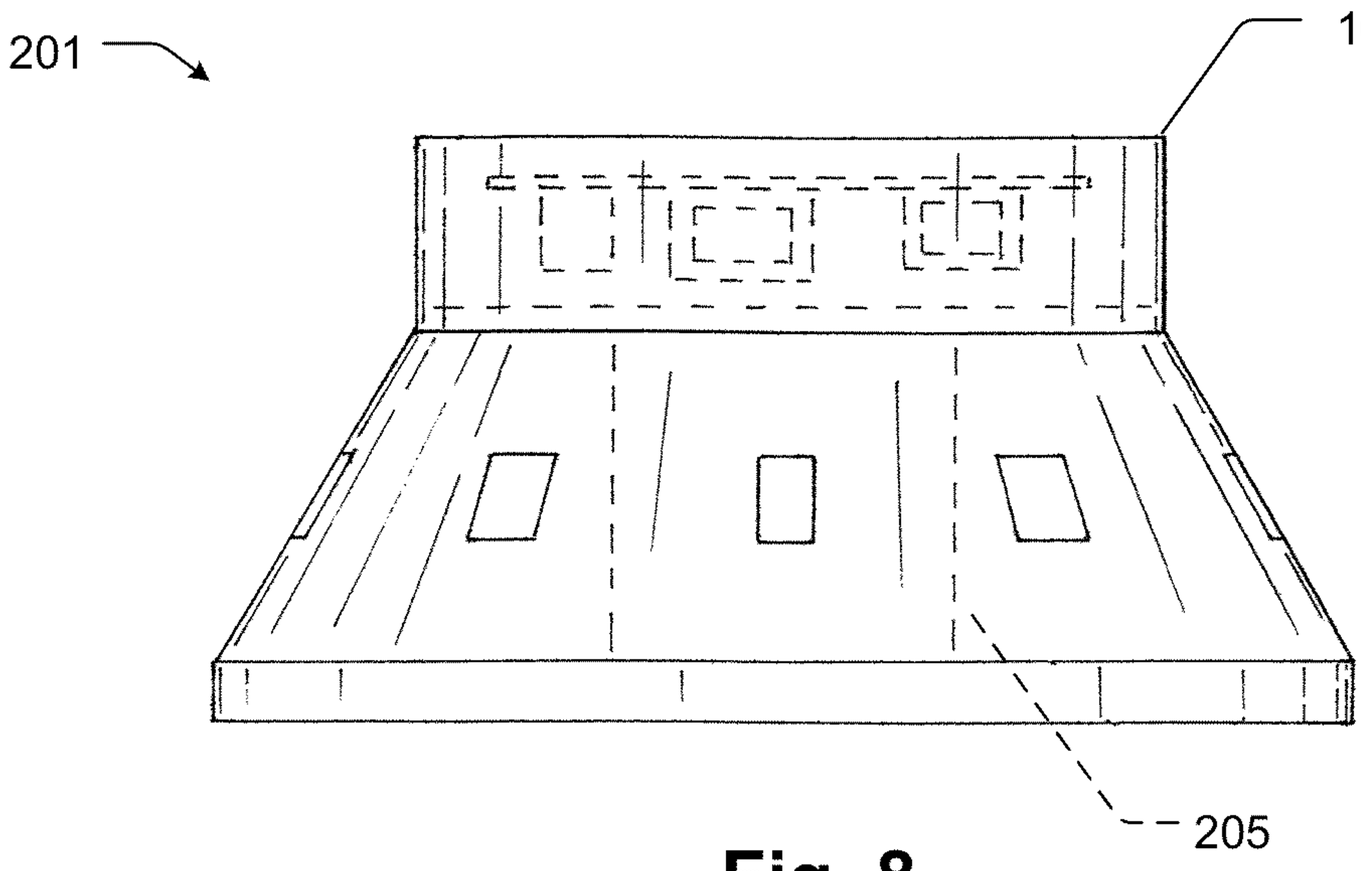

Fig. 8

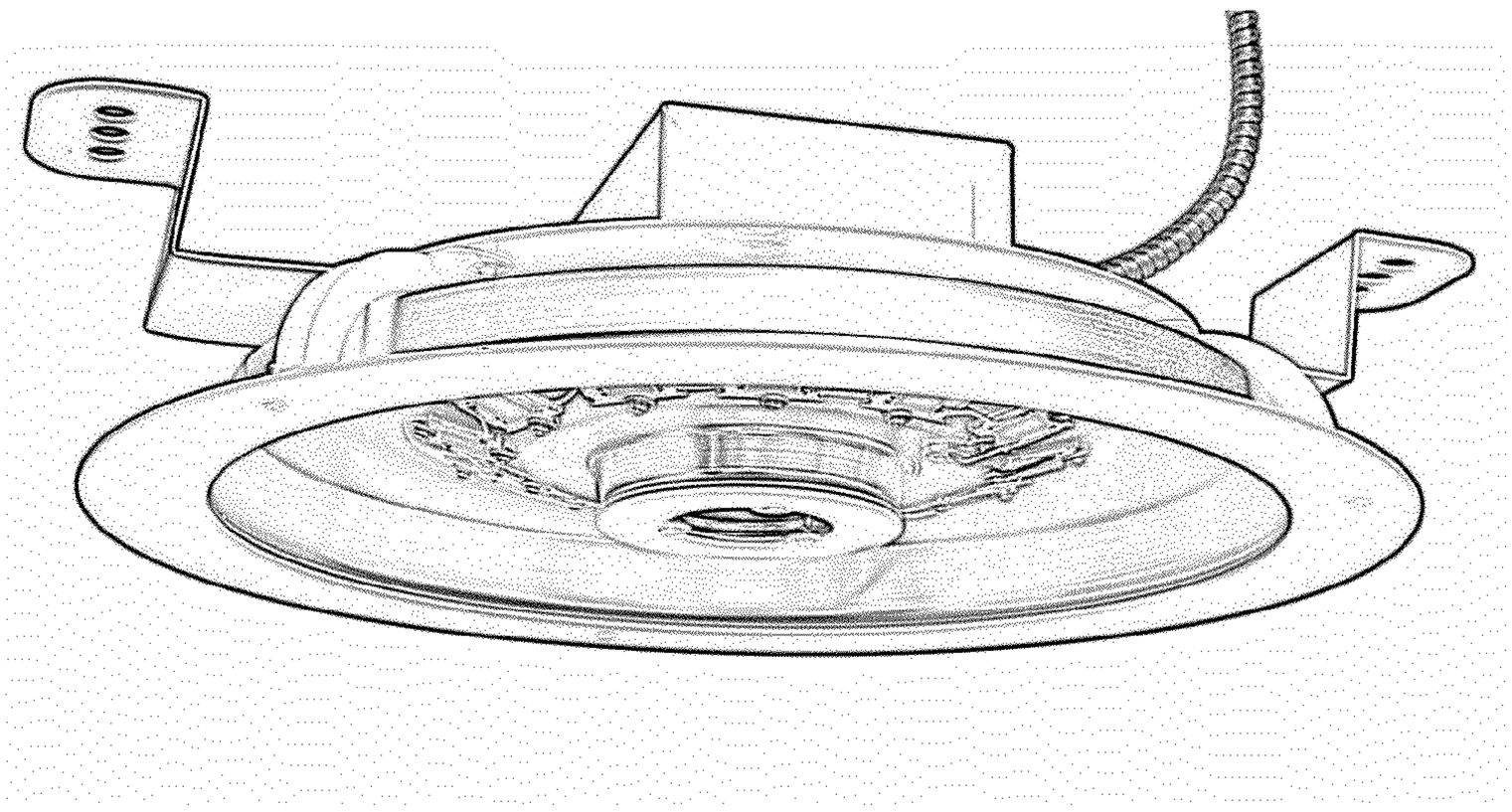

Fig. 9

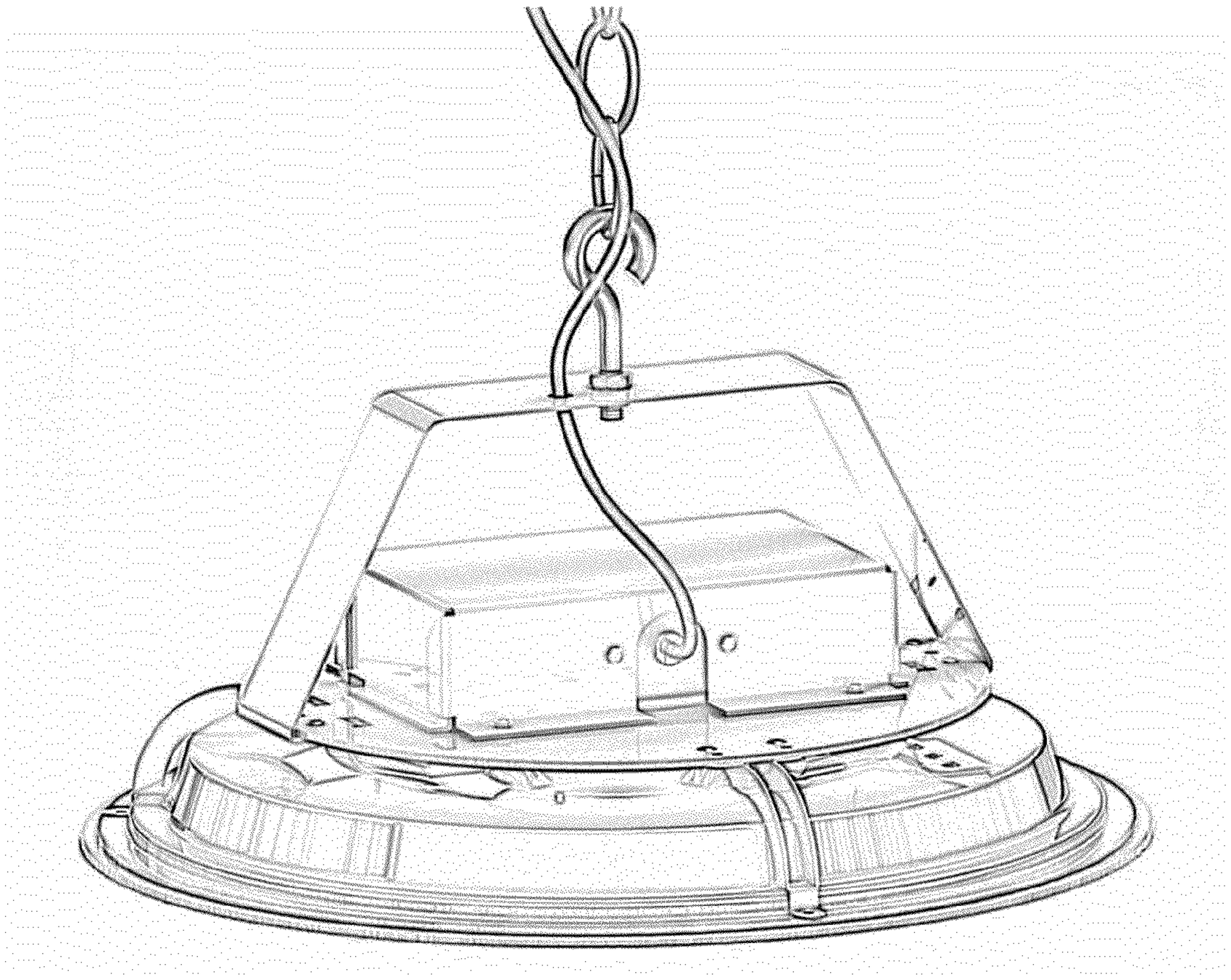

Fig. 10

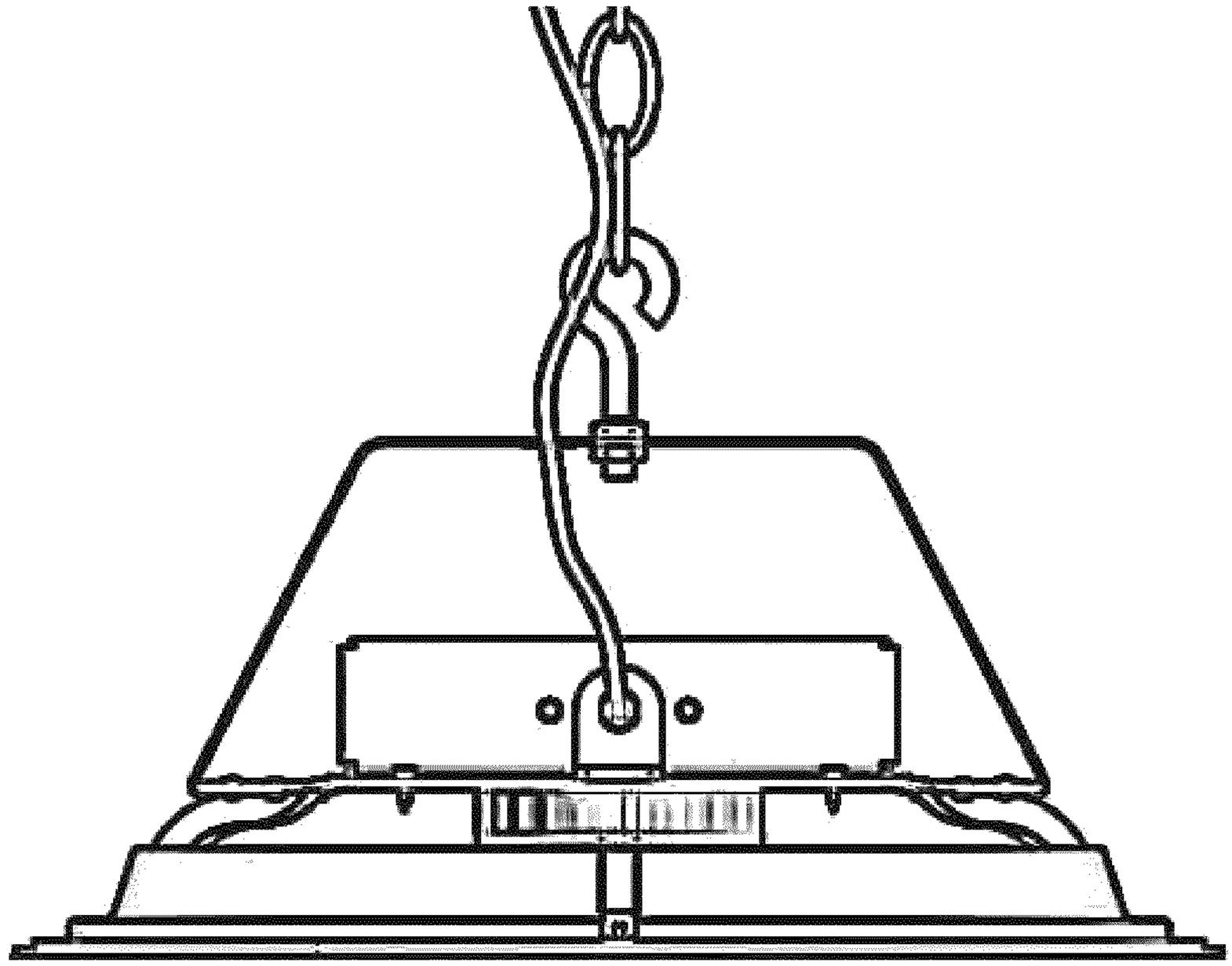

Fig. 11

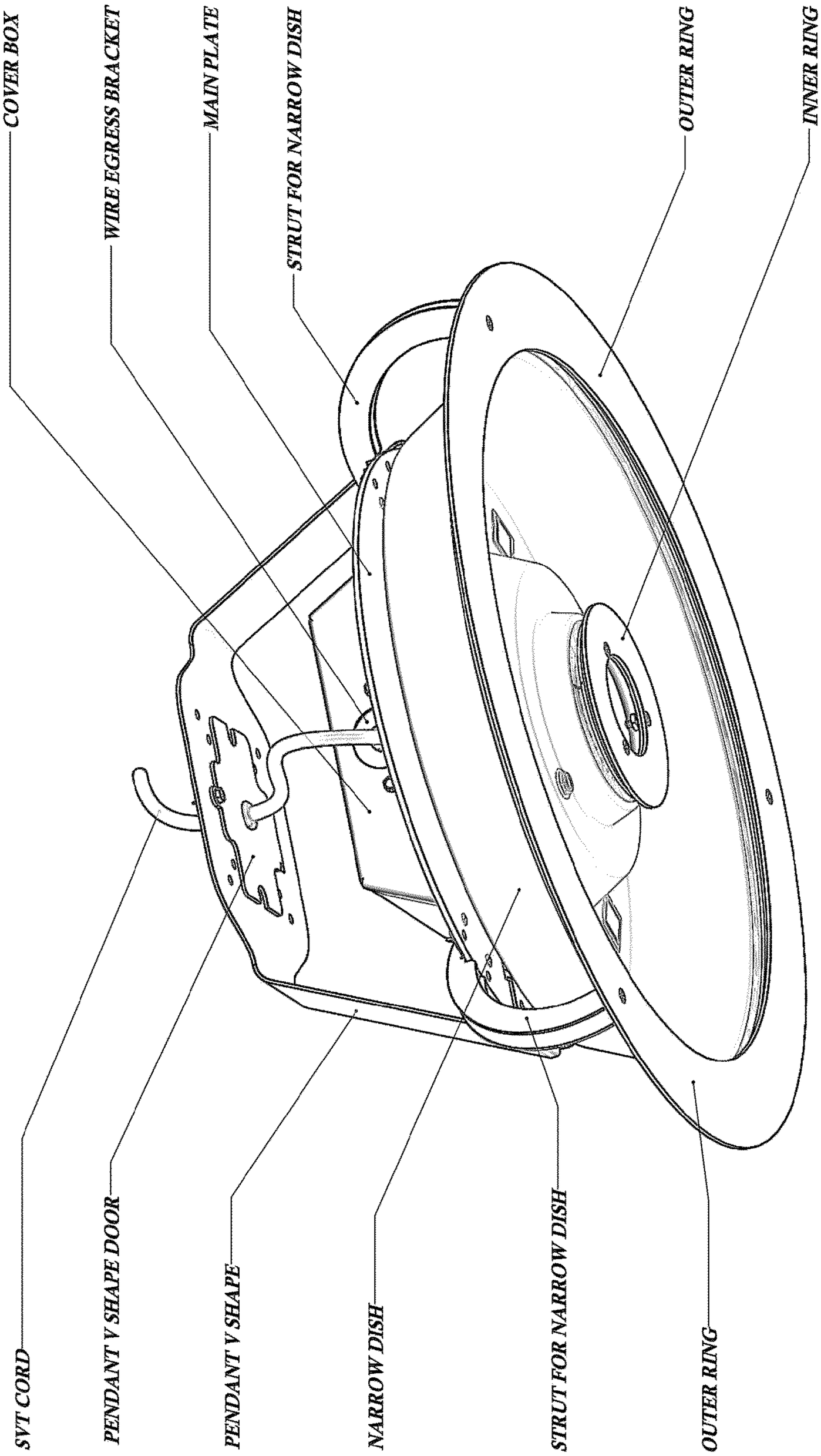
COVER BOX
WIRE EGRESS BRACKET
MAIN PLATE
STRUT FOR NARROW DISH
OUTER RING
INNER RING
SVT CORD
PENDANT V SHAPE DOOR
PENDANT V SHAPE
NARROW DISH
STRUT FOR NARROW DISH
OUTER RING

Fig. 12

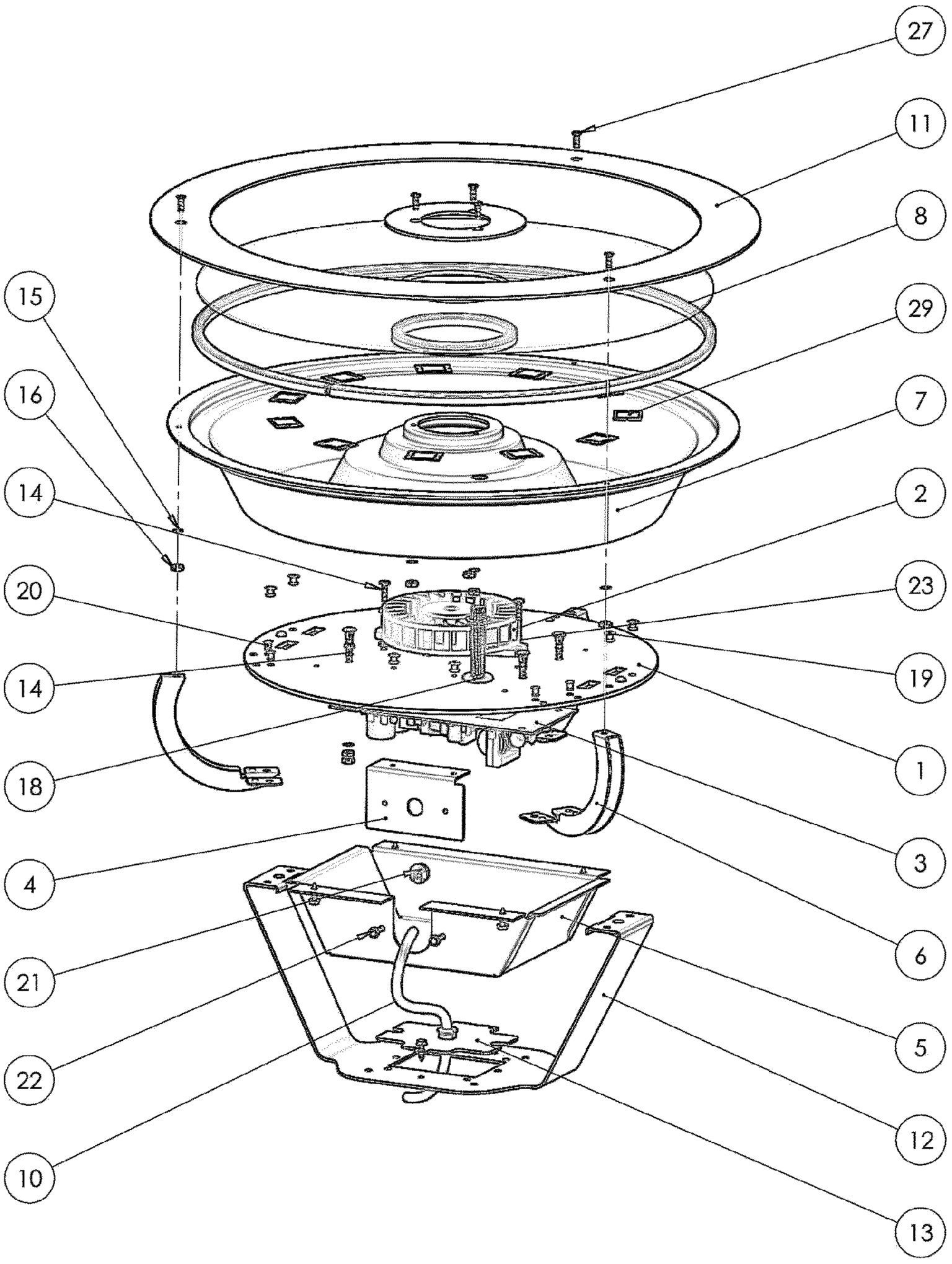

Fig. 13a

ITEM NO.	PART NUMBER	NAME
1	HB-001	MAIN PLATE
2	HB-002	FAN
3	HB-003	POWER BOARD
4	HB-004	WIRE EGRESS BRACKET
5	HB-005	COVER BOX
6	HB-006-B	STRUT FOR NARROW DISH
7	HB-007-B	NARROW DISH
8	HB-008	GLASS
	HB-009	INNER RING
	HB-010	OUTER RING
12	HB-011-C1	PENDANT V SHAPE
13	HB-011-C2	PENDANT V SHAPE DOOR
	HB-C-001	MACHINE SCREW
	HB-C-002	EXTERNAL TOOTH LOCK WASHER
	HB-C-003	NUT
	HB-C-004	STAND OFF FOR PCB
	HB-C-005	RUBBER GROMMET
	HB-C-006-A	STANDARD RIVETS
	HB-C-006-B	RIVETS FOR STRUTS
	HB-C-007	STRAIN RELIEF BUSHINGS
	HB-C-008	SHEET METAL SCREW
	HB-C-009-B	STEEL NIPPLE
	HB-C-010	LOCK WASHER SLIPS
	HB-C-011	ZINC LOCKNUT
	HB-C-012	REGULAR WASHER
	HB-C-013	FLAT HEAD SCREW
	HB-C-014	LENS GROMMET
29	HB-E-001	SQUARE LED 16x16mm
10	HB-E-002	SVT CORD FOR V PENDANT

Fig. 13b

LED HIGH BAY LIGHTING SOURCE

REFERENCE TO RELATED APPLICATIONS

This patent application claims the benefit of priority under 35 USC sections 119 and 120 of a provisional patent application filed Jun. 13, 2012 having Application Ser. No. 61/659,398. The entirety of the said U.S. provisional application 61/659,398, entitled "LED High Bay Lighting Source", is incorporated by reference herein.

BACKGROUND

This invention relates to lighting systems, in particular lighting systems for illuminating extended areas, such as at a warehouse, walk-in cooler, or retail area.

In earlier decades, fluorescent and incandescent lights were used to provide electric powered illumination. As is well known, LED (Light Emitting Diode) technology provides more energy efficient light output compared to the light output efficiency of the prior technologies. However, an LED chip's lighting geometry differs from that of the previous lighting sources. The LED chip's lighting emission surface tends to have essentially planar emission surface of an incandescent bulb or tubular emission surface as with some fluorescent sources.

Therefore, though LED technology is more efficient, the characteristically flat LED sources may not be desirable for some applications, for example, with existing lighting fixtures using bulb-shaped sources. Despite having different light source emission geometry, there is a need in the art for LED lighting configurations that produce substantially the same lighting patterns as prior lamp technology lighting systems.

SUMMARY

One object of the present invention is to provide a sufficiently bright and radially uniform lighting pattern in spite of the substantially planar LED surface shape, and despite gaps between LEDs. Another object of the invention is to accommodate properly conditioned electrical supply to and heat removal from the LEDs. Still other objects of the present invention are that in addition to being an energy efficient lighting source, this lighting system is intended to be easy to assemble and robust.

In one embodiment of the present invention, a lighting device includes a housing having an inner surface and outer surface and a plurality of LEDs mounted at the inner surface, the LEDs mounted in a radially symmetrical configuration. The inner surface may be made of or coated with reflective material.

The lighting system may further include heat sink fins mounted on the outer surface of said housing, each heat sink fin mounted proximal to a corresponding LED but at the opposite surface of the housing. The lighting system may further include a reflective plate mounted within the housing for reflecting light from the LEDs in a desired direction. The lighting system may further include a reflective tube disposed coaxially within the housing for redirecting light from the LEDs.

The lighting system may further include a light transmissive plate attached to the housing by a retaining ring. The lighting system may further include a circuit board including electrical components connected to the LEDs, the components adapted to transform input electrical power for deliver to the LEDs.

In another embodiment of the present invention, a lighting device includes a housing including a cylindrical section and a conic section, the conic section having an inner surface and outer surface. A plurality of LEDs are mounted to the housing at the inner surface, the LEDs mounted in a radially symmetrical configuration. A plurality of heat sink fins mounted to the housing at the outer surface. Each heat sink fin is mounted proximal to a corresponding LED but at the opposite surface of the housing. A reflective plate is mounted within the housing for reflecting light from the LEDs in a desired direction. A reflective tube is disposed coaxially within the housing for redirecting light from the LEDs. An optional light transmissive plate is attached to the housing by a retaining ring.

Further aspects of the present invention will become apparent from the following detailed description when considered in conjunction with the accompanying drawings. It should be understood, however, that the detailed description and the specific examples while representing the preferred embodiments are given by way of illustration only.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a lighting device in accordance with one embodiment of the present invention;

FIG. **2** is a bottom view of the lighting device of FIG. **1**;

FIG. **3** is another bottom plan view of the lighting device of FIG. **1** showing additional elements;

FIG. **4** is a side view of the lighting device of FIG. **1**;

FIG. **5** is another side view of the lighting device of FIG. **1** but with hidden elements illustrated;

FIG. **6** is a cutaway side view of a portion of the lighting device of FIG. **1** illustrating the portion in more detail;

FIG. **7** is bottom view of an alternative modified lighting assembly;

FIG. **8** shows a side elevation view of the modified lighting assembly of FIG. **7**;

FIG. **9** shows a perspective view of another embodiment of the invention, featuring wings with holes for mounting to a ceiling or other structure;

FIG. **10** shows a perspective view of yet another embodiment of the invention, featuring a bracket and hook for mounting to a suspended chain;

FIG. **11** shows a side view of the embodiment as in FIG. **10**;

FIG. **12** shows a perspective view of yet another embodiment of the invention, featuring struts for securing a main plate to an outer ring;

FIG. **13***a* shows a disassembled view of the embodiment in FIG. **12**, with detail of a fan and power board; and

FIG. **13***b* shows a parts list for the elements called out numerically in FIG. **13***a*.

DETAILED DESCRIPTION

The present invention will now be described with reference to the FIGS. **1** through **8** which illustrate various aspects, embodiments, or implementations of the present invention. In the Figures, some sizes of structures, portions, or elements may be exaggerated relative to sizes of other structures, portions, or elements for illustrative purposes and, thus, are provided to aid in the illustration and the disclosure of the present invention. In this document, terms "above" and "below", "upper" and "lower" are intended only for convenience in referring to drawing orientation. In actual use, alternate lighting assembly orientations are possible.

While the present invention is capable of embodiment in many different forms, the drawings show preferred embodi-

ments of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to the embodiments illustrated.

FIG. **1** shows a lighting device **101** in accordance one embodiment of the present invention. FIG. **2** is a bottom view of the lighting device **101** of FIG. **1**. FIG. **3** is another bottom view of the lighting device of FIG. **1** showing additional elements. FIG. **4** is a side view of the lighting device of FIG. **1**. FIG. **5** is another side view of the lighting device of FIG. **1** but with hidden elements illustrated. FIG. **6** is a cutaway side view of a portion of the lighting device of FIG. **1** illustrating portions in more detail.

Referring to FIGS. **1** through **6** inclusive, but mostly to FIG. **1**, the lighting device **101** includes a housing **105**, the housing **105** having two sections—a hollow cylindrical section **106** (herein after referred to as the "cylindrical section" **106**) and a truncated hollow conic section **107** (hollow frustoconical section, herein after referred to as the "conic section" **107**), the conic section **107** attached to the cylindrical section **106**. The conic section **107** having an inner surface **108**. The conic section **107** and the cylindrical section **106**, together, are referred to as the housing **105**.

The housing **105** is substantially hollow with open ends, serving as a support structure with openings for light to pass through. In the illustrated embodiment, the housing **105**, as illustrated, is a truncated hollow cone attached to a hollow cylinder, but, in other embodiments, may be fashioned in other shapes, for example a bell, hemispherical or ellipsoidal shape, or sections thereof. Also, though the housing **105** is shown as a shape that could be made of sheet material for ease of construction, it should be understood that a hollow solid with the same or similar internal surface shape could also be used to provide a housing for the present invention. Alternatively, instead of the housing sides being angled or contoured to form a partial cone or bell shape, the underside of the housing **105** may be substantially flat, as a plate.

A plurality of LEDs **115** are mounted in or to the housing **105** at the inner surface **108** of the housing **105**. The inner surface **108** of the housing **105** is preferably made of or coated with a reflective material thereby reflecting light generated by the LEDs **115**. The LEDs **115** are illustrated as having rectangular shape, but it should be understood that LEDs of other shapes may be used, for example LEDs having round or polygonal geometric shapes. As illustrated, the LEDs **115** are mounted in a radially symmetrical configuration.

At one open end of the housing **105**, a light transmissive plate **130** may be attached to the housing **105**, providing protection for the LEDs **115** while allowing the light from the LEDs **115** to pass through. In FIG. **1**, reference number **130** generally points to the light transmissive plate **130**. The transmissive plate **130** provides a barrier against dust and moisture, thus protecting the LEDs **115**. The light transmissive plate **130** may be clear, translucent, or frosted, for example, as long as it allows the light generated within the housing **105** to emerge from the device **101**. A retaining ring **120** retains the light transmissive plate **130** in place. Fasteners **125** attach the retaining ring **120** to the housing **105**.

Continuing to refer to FIGS. **1** through **6**, but mostly to FIG. **2**, LED wires **145** connect the LEDs **115** to, ultimately, an external power source (not illustrated). As shown, the LED wires **145** may be routed on the inner surface **108** of housing **105**. Alternatively, the LED wires **145** may be placed within the housing **105** (e.g. via grooves or holes) to allow different wire routing if desired.

A reflective plate **135** may be placed within the housing **105** to reflect light from the LEDs **115** in a desired direction. Reflective plate fasteners **140** engage the reflective plate **135** to the housing **105**.

FIG. **3** is another bottom view of the lighting device of FIG. **1**; however, in FIG. **3**, the reflective plate **135** is displaced (for the purposes of illustration) to show additional elements of the present invention. The displacement of the reflective plate shows a circuit board **160** mounted within the housing **105** and an inner grommet **155**. The circuit board includes various electronic components **161** to which the LEDs **115** are connected via the LED wires **145**. A power wire **165** delivers external electrical power to the components **161**. The components **161** operate on the delivered power to convert the external power to be suitable for delivery to the LEDs **115**. A ground wire **170** provides grounding to reduce the risk of electric shock.

Continuing to refer to FIGS. **1** through **6**, the housing **105** has outer surface **109** on which heat sink fins **110** may be mounted. In the illustrated embodiment, the fins **110** are mounted proximal to each of the LEDs **115**, each fin **110** preferably directly opposite each corresponding LED **115** at the inner surface **108** of the housing **105**, so as to optimize heat transfer. The outer surface **109** is the opposite surface compared to the inner surface **108** of the housing **105**.

To better explain the relative placement of the heat sinks **110** and the LEDs **115**, from a geometric point of view, one may designate a central axis for housing **105**, from which to base a cylindrical coordinate system to refer to the placement of each attached component. Preferably, each heat sink **110** and each LED **115** are placed at substantially the same angles around the conical part of the housing **105** and at the same height relative to housing **105**, the only difference that the heat sinks are slightly more outward from the axis than the LEDs. Again, this configuration minimizes the distance between each LED **115** toward the inside of the housing and corresponding heat sink fin **110** toward the outside of the housing, thus optimizing the heat transfer from the housing inside to the outside. This relative positioning is better illustrated in FIG. **5**.

FIG. **5** is another side view of the lighting device of FIG. **1** but with selected elements illustrated with dashed lines for even more clarity. FIG. **5** illustrates the heat sink fins **110** placed proximal to each of the LEDs **115**. As an example, the LED **115***a*, mounted at the inner surface **108** of the housing **105** is proximal to its corresponding heat sink fin **110***a*, mounted at the outer surface **109** of the housing **105**.

Also illustrated is the circuit board **160** placement inside the cylindrical section **106** of the housing **105**. The power wire **165** extends beyond the lighting device **101**.

FIG. **6** is a cutaway side view of a portion of the lighting device **101** illustrating the portion in more detail. In particular, FIG. **6** is a side cutaway view of a portion indicated as dash box **122** of the lighting device **101** (see FIGS. **4** and **6**) illustrating the technique used to attach the transmissive plate **130** to the housing **105**. The housing **105** and the retaining ring **120** define openings that are aligned. Fasteners **125** are threaded through the aligned openings. The fastener **125** engages a grommet **150**, the grommet **150** having a D-shaped cross section, thereby securing the retaining ring **120** to the housing **105**. The transmissive plate **130** is positioned between the housing **105** and the retaining ring **120**. Because the retaining ring **120** has an L-shaped cross section, the retaining ring **120** is able to secure the transmissive plate **130** between itself and the housing **105**.

FIGS. **7** and **8** show an alternative embodiment of the lighting device **201**. Referring to FIGS. **7** and **8**, the lighting

device **201** is configured substantially similar to the lighting device with some variances. The lighting device **201** features a reflective tube **205** disposed coaxially within the housing **105** running mostly at bottom center of the housing **105**. The reflective tube **205** serves as a light redirector. The reflective tube **205** modifies angular spread of the light reaching from the LEDs away from the lighting device **201** toward the desired direction such as, for example, floor, product, and work areas, while blocking direct LED view from passerby and other personnel in the area. Direct light means light (or a beam of light) that is in the direct line of sight of the light producing device, in other words, non-reflected light. Though light redirector **205** is shown having a cylindrical shape, it may also be formed as a cone, hourglass, or bulb shaped structure as needed to adjust and modify the light output from the lighting unit.

It will be appreciated by one skilled in the art that the objects of the invention are achieved by the embodiments disclosed above. The lighting pattern effectively uses the light output from the substantially planar LEDs and redistributes it in a pattern that is helpful for use in a warehouse, walk-in cooler, or retail area. The construction of the lighting system is also flexible enough to be readily adapted for an assembly line.

Additionally, it is possible to modify the basic invention by adding mounting wings as in FIG. **9**, or a bracket with hook as in FIGS. **10** and **11**. It is further possible to reinforce the construction with struts as in FIG. **12**.

Moreover, it is possible to add a cooling fan and electronics to control the fan. This is shown in FIG. **13***a*. The fan **2** may be ran from power conditioning supplied by circuit power board **3**. The power board **3** may perform functions such as power factor correction and total harmonic distortion reduction, to be in compliance with utilities that favor or require a sinusoidal current draw in phase with the voltage. Power board **3** may also monitor the system temperature and modify the fan speed, whether by turning it on or off, or varying the speed, to control temperature. Power board **3** may also have remote control functions to allow turning on or off at various times of day or lighting conditions. Power board **3** may also be configured to perform a dimming function.

To conclude, with respect to the above description, it is to be understood that the optimal dimensional specifications for the parts of the invention, including variations in number, size, shape, form, placement, material and the method of fabrication and assembly, are deemed readily apparent to persons skilled in the art upon a reading of the foregoing description, and all equivalent specifications to those illustrated in the drawings and detailed in the description are intended to be encompassed by the present invention.

What is claimed is:

1. A lighting device comprising:
a housing having an inner surface and outer surface;
a plurality of LEDs mounted at the inner surface, the LEDs mounted in a radially symmetrical configuration;
a reflective tube disposed coaxially within the housing for redirecting light from the LEDs;
heat sinks mounted on the outer surface; and
wherein each heat sink fin and each LED are placed at substantially the same angles around the housing and at the same height relative to the housing.

2. A lighting device comprising:
a housing including a cylindrical section and a conic section, the conic section having an inner surface and outer surface;
a plurality of LEDs mounted to the housing at the inner surface, the LEDs mounted in a radially symmetrical configuration;
a reflective tube disposed coaxially within the housing for redirecting light from the LEDs; and
a plurality of heat sink fins mounted to the housing at the outer surface.

3. A method of producing light, the method comprising:
placing a plurality of LEDs around the interior of a housing having inner and outer sides;
placing a reflective tube coaxially within the housing for redirecting light from the LEDs; and
placing a plurality of heat sink fins at substantially the same angles as the LEDs placed around the housing.

* * * * *